



Grower Summary

HNS 198

Improving weed control in
hardy nursery stock

Annual Report

Project title: Improving weed control in hardy nursery stock

Project number: HNS 198

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The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

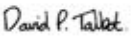
AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

David Talbot

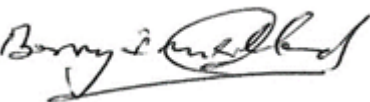
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Date: 13 March 2020

Report authorised by:

Signature 

Date: 13 March 2020

Grower Summary

Headlines

- For budded tree production in the field, herbicide programmes of Sencorex Flow + Stomp Aqua + Venzar 500 SC + Sunfire after planting and after heading back proved safe and effective.
- HDC 42, HDC H43, HDC H44, HDC H46 and HDC H47 proved safe and effective on field-grown trees post budding when tank mixed with Sencorex Flow + Stomp Aqua + Venzar 500 SC.
- Sencorex Flow at 1.15 L/ha proved safe, applied as a post-planting and post heading back treatment to four tree species.
- Defy applied as a late winter treatment appears crop safe on the majority of species tested.
- Flexidor tank mixed with Centurion Max, Dual Gold and Sunfire was tolerated by 19 of the 20 hardy nursery stock species when applied after potting. A few species showed short-term phytotoxicity symptoms but plants grew away from the damage by 12 weeks after treatment.
- Flexidor at 0.5 L/ha (the maximum rate) proved safe (by 12 weeks after treatment) on the majority of species tested.

Background

A decreasing number of herbicides are available to the Hardy Nursery Stock (HNS) sector for efficient plant production and as a result, effective weed control has become an urgent problem for the industry to solve.

Since the last herbicide trial on field-grown trees in the UK was completed in 2012 (CP 086), the key recommended products, Ronstar Liquid (oxadiazon) and Devrinol, have become unavailable for use. Although Devrinol has recently been issued an Extension of Authorisation for Minor Use (EAMU) for use in ornamentals, its restrictions prevent the product's use in many field-grown production systems. This combined with the restriction of one application of Flexidor per crop has resulted in a pressing need to test replacement products for tree production.

The herbicides selected for inclusion in the field tree trials are those for which appropriate EAMUs have recently been granted, e.g. Sencorex Flow (metribuzin) and Springbok (metazachlor + dimethenamid-p), alongside some newer products that are not yet authorised. In 2016, this project looked at the efficacy and crop safety of two-season herbicide programmes, including these new products for field rose production. The aim of the current trials was to build on the knowledge gained from the previous trials in roses, and to include new products alongside robust herbicides such as Sencorex Flow in other field-grown ornamentals.

The final use of Ronstar 2G (oxadiazon) in 2015 and restrictions on the use of Butisan S (metazachlor) have left gaps in the herbicides available to growers of container hardy nursery stock. Flexidor 500 (isoxaben) – previously Flexidor 125 – has become the mainstay of weed control programmes in container hardy nursery stock production, but it does not offer control of annual meadow grass, groundsel, willowherb, moss or liverwort, and now only one application is permitted per year. Research in the projects CP 86 *'Weed control in ornamentals, fruit and vegetable crops – maintaining capability to devise suitable weed control strategies'* (Atwood, 2015) and HNS/PO 192 & 192a *'Herbicides screening for ornamental plant production (nursery stock, cut flowers and wallflowers)'* (Atwood 2015, 2016), have investigated promising new actives in screening trials, and reviewed cultural controls. As a result, Dual Gold (s-metolachlor) and Springbok were developed as container hardy nursery stock treatments (though with limitations). Since then additional crop safety screening has been carried out within this project. Currently, relatively few new residual herbicides show potential for container hardy nursery stock testing, but two were selected for 2017-18 trials; Sunfire (flufenacet) and Defy (prosulfocarb), both promising for efficacy on key weeds and safety on indicative nursery stock species, additional crop safety screening has continued to demonstrate their potential. Two new herbicide actives (both coded products) were also selected for inclusion in 2018 and 2019 trials; HDC H44 and HDC H46. The withdrawal of Aramo (tepraloxydim), a selective contact herbicide for grass control, has had an impact across both field and container-grown hardy nursery stock. It was used as a post-emergence control of a range of annual grasses, in particular annual meadow grass. A safe and effective replacement, Centurion Max (clethodim) was selected as the most promising candidate and included in phytotoxicity screening on indicative nursery stock species. This was done alone and as a tank mix with Flexidor where it has proved its potential for use within the majority of species tested.

HDC H46 is a potential new active for the UK; it is approved in other countries and is used in hardy nursery stock production, and therefore was included in the 2018 and 2019 container screening tests and 2019 field trials. The UK formulation is likely to be different to

the formulation used in hardy nursery stock production in other countries. It gives pre-emergence residual control of a range of annual grasses and broad-leaf weeds including the following weed species: Hairy bittercress, Common chickweed, Mouse eared chickweed, Groundsel, Annual meadow Grass, Clovers and Italian Ryegrass.

Due to the delays in converting the Long Term Arrangements for Extensions of Use (LTAEU) to EAMUs, a number of products are still available under the LTAEU. Some of these are included to give growers crop safety information as EAMUs are issued.

Summary

During 2019 four herbicide trials were carried out, two trials each on container-grown nursery stock and field-grown trees. Phytotoxicity testing on 30 container-grown hardy nursery stock subjects was done in two other, separate trials. **Table 1** lists the herbicides and rates used in each trial, along with the herbicides' approval status.

Table 1. Herbicides, approval status and rates used in hardy nursery stock trials carried out in 2019.

Product	Active	Approval status	2018 Field tree trial year two (L/ha)	2019 Field tree trial (L/ha)	HNS Container trial 2018 year two (L/ha)	HNS Container trial 2019 (L/ha)
Centurion Max	120 g/L clethodim	LTAEU				2.0
Defy	800 g/L prosulfocarb	EAMU ¹			5.0	
Dual Gold		EAMU				0.78
Flexidor 500	500 g/L isoxaben	Label		0.5		0.5
HDC H42	Confidential	Not authorised		1.5		
HDC H43	600 g/L pethoxamid	Not authorised	2.0	2.0		2.0
HDC H44*	Confidential	Not authorised	1.5	1.75		
HDC H46	Confidential	Not authorised	0.1	0.1	0.1	0.1
HDC H47	Confidential	Not authorised	3.75	3.75		

Laser²	Cycloxydim	EAMU	2.25			
Sencorex Flow	600 g/L metribuzin	EAMU	1.0 and 1.15	1.0 and 1.15		
Shark	60 g/L carfentrazone ethyl	EAMU		0.8		
Springbok	200 g/L metazachlor + 200 g/L dimethenamid-p	EAMU		2.5		1.66
Stomp Aqua	455 g/L pendimethalin	EAMU	2.9	2.9		
Sunfire	500 g/L flufenacet	EAMU		0.48		0.48
Venzar 500 SC	500 g/L lenacil	LTAEU now EAMU	0.4	0.4	0.4	0.4

¹ Pre-emergence only, ²Toil was added at 5 ml per L of water.

*HDC H44 has been evaluated on wide range of horticultural crops in the SCEPTRE plus project. The active is authorised for use in potatoes and has a number of EAMUs and label extensions for other crops.

2018 Field Tree Trial year two

The 2018 field tree trial was set up on newly planted rootstocks at Frank P Matthews, Worcestershire in 2018 (see 2018 annual report for results from year one). The aim of the work carried out in year two (2019) of this study was to test the crop safety and efficacy of a number of residual herbicides as alternatives to Flexidor, post heading back (rootstocks cut back to just above the bud that was budded the previous season). There is an increased reliance on Flexidor, however the new label only permits one application per crop, so growers need alternative residual options.

The trial was set up so that each plot contained four tree species (e.g. *Malus*, *Prunus*, *Quince* and *Sorbus*). The trial consisted of eight herbicide treatments that were applied as residual pre-emergence treatments post heading back of rootstocks (Table 2). Phytotoxicity and weed assessments were carried out at 4, 6 and 12 weeks after treatment (WAT). Phytotoxicity was scored on a scale of 0-9; plants scoring 0 were considered dead, and 9 considered healthy, with plants scoring 7 or more considered to be of commercially acceptable quality. Weed cover was assessed as an overall percentage of the plot.

Sencorex was tested at the maximum rate (1.15 L/ha); a higher rate than previously used on the test species and it proved to be crop safe at this higher rate; experimental treatments also proved crop safe with no phytotoxicity recorded on any treatments or assessment dates.

Table 2. Treatment list and percentage weed cover, 4, 6 and 12 WAT (assessed 09/04/19, 24/04/19 and 05/06/19).

Trt. No.	Post heading back ** 11/03/19	Rate (L/ha)	Weed cover (%) 4 weeks	Weed cover (%) 6 weeks	Weed cover (%) 12 weeks
1	Untreated	-	0	83.7	98.8
2	Sencorex Flow + Stomp Aqua + Venzar 500 SC + HDC H47	1 L/ha + 2.9 L/ha + 0.4 L/ha + 3.75 L/ha	0	0	0.75
3	Sencorex Flow + Stomp Aqua + Venzar 500 SC + HDC H44	1 L/ha + 2.9 L/ha + 0.4 L/ha + 1.5 L/ha	0.3	1	2.5
4	Sencorex Flow + Stomp Aqua + Venzar 500 SC + Sunfire	1 L/ha + 2.9 L/ha + 0.4 L/ha + 0.48 L/ha	0.3	0.75	2.8
5	Sencorex Flow + Stomp Aqua + Venzar 500 SC + HDC 43	1 L/ha + 2.9 L/ha + 0.4 L/ha + 2.0 L/ha	0.5	2.5	8.5
6	Sencorex Flow + Stomp Aqua + Venzar 500 SC + HDC H46	1 L/ha + 2.9 L/ha + 0.4 L/ha + 0.1 L/ha	0.3	2	3
7	HDC H46	0.1 L/ha	0.3	1.8	8.3
8 and 9	Sencorex Flow + Stomp Aqua + Venzar 500 SC	1 L/ha + 2.9 L/ha + 0.4 L/ha	0	1.1	5.3
10	Sencorex Flow	1.15 L/ha	0	1	3.8

**Laser (EAMU) was applied at 2.25L/ha in 330 L/ha water with a 02F110 nozzle at medium spray quality with the adjuvant Toil a 5ml per litre of water.

The trials showed that both HDC 46 and Sencorex Flow have gaps in their weed control spectrums when applied alone, therefore they should be used with complimentary tank mix partners.

None of the treatments applied resulted in phytotoxic damage on any of the four species 2, 6 or 12 WAT. All of the post-heading back treatments were crop safe and effective and resulted in significantly improved weed control compared to untreated controls, see **Table 2, appendix 1** in the science section).

2019 Field Tree Trial

The 2019 field tree trial was set up on newly planted rootstocks at Frank P Matthews, Worcestershire in 2019. The aim of the work was to build on the results of the field tree trial carried out in 2018; continuing to test the crop safety and efficacy of a number of residual herbicides as alternatives to Flexidor, whilst developing residual herbicide programmes for use post-planting.

The trial was set up with each plot containing four tree species (e.g. *Malus*, *Prunus*, *Quince* and *Sorbus*) and three replicate blocks. The trial consisted of nine herbicide treatments which were applied on 29/04/19 as residual pre-emergence treatments post heading back of rootstocks. Phytotoxicity and weed assessments were carried out at two, six and twelve weeks after treatment (WAT).

Sencorex was tested at the maximum rate (1.15L/ha); a higher rates than previously used on the rootstocks and proved to be crop safe at this higher rate. Coded experimental treatments (alone or included in tank mixes – treatments 2, 3, 5, 6, 7 & 8) also proved crop safe at 12 WAT with no commercially unacceptable damage recorded.

Table 3. Percentage weed cover, 2, 6 and 12 WAT (assessed 15/05/19, 12/06/19 and 26/07/19)

Trt. No.	Treatment	Rate (L/ha)	Weed cover (%) 2 weeks	Weed cover (%) 6 weeks	Weed cover (%) 12 weeks
1	Untreated	-	1	58.3	98.3
2	Sencorex Flow + Stomp Aqua + Venzar 500 SC + HDC H47	1 L/ha + 2.9 L/ha + 0.4 L/ha + 3.75 L/ha	0	5	8
3	Sencorex Flow + Stomp Aqua + Venzar 500 SC + HDC H44	1 L/ha + 2.9 L/ha + 0.4 L/ha + 1.75 L/ha	0	0.3	1.7
4	Sencorex Flow + Stomp Aqua + Venzar 500 SC + Sunfire	1 L/ha + 2.9 L/ha + 0.4 L/ha + 0.48 L/ha	0	1	2.3
5	Sencorex Flow + Stomp Aqua + Venzar 500 SC + HDC H43	1 L/ha + 2.9 L/ha + 0.4 L/ha + 2.0 L/ha	0	1	2.3
6	Sencorex Flow + Stomp Aqua + Venzar 500 SC + HDC H46	1 L/ha + 2.9 L/ha + 0.4 L/ha + 0.1 L/ha	0	0.3	1.3
7	HDC H46	0.1 L/ha	0	2	48.3
8	Sencorex Flow + Stomp Aqua + Venzar 500 SC + HDC H42	1 L/ha + 2.9 L/ha + 0.4 L/ha + 1.5 L/ha	0	0	0.3
9	Sencorex Flow + Stomp Aqua + Venzar 500 SC	1 L/ha + 2.9 L/ha + 0.4 L/ha	0	0.7	1.7
10	Sencorex Flow	1.15 L/ha	0	1.3	10

None of the herbicide treatments had more than 10% mean weed cover by 12 weeks after treatment. The untreated controls had a mean weed cover of over ninety eight percent by twelve weeks after treatment. The most effective treatment combinations are listed in **Table 4** below, see **Table 3** above for full results.

The least effective treatment was treatment 7 (HDC H46 applied alone) with 48.3% weed cover by 12 WAT however treatment 3 (HDC H46 applied as part of a tank mix) resulted in 1.3% weed cover 12 WAT. Treatment 10 (Sencorex Flow at the maximum rate) resulted in 10% weed cover which was higher than many of the tank mix combinations where Sencorex Flow was used at a lower rate. This suggests that both HDC 46 and Sencorex Flow have gaps in their weed control spectrums when applied alone without complimentary tank mix partners, as found in year two of the 2018 Field Tree Trial.

Table 4. Four most effective treatments for weed control (Percentage weed cover, 2, 6 and 12 WAT, assessed 15/05/19, 12/06/19 and 26/07/19).

Treatment number	Product (name)	Active ingredient	Rate (L/ha or kg/ha)	Percentage mean weed cover at 12 WAT*
8	Sencorex Flow + Stomp Aqua + Venzar 500 SC + HDC H42	metribuzin + pendimethalin + lenacil + Confidential	1 L/ha + 2.9 L/ha + 0.4 L/ha + 1.5 L/ha	0.3
6	Sencorex Flow + Stomp Aqua + Venzar 500 SC + HDC H46	metribuzin + pendimethalin + lenacil + Confidential	1 L/ha + 2.9 L/ha + 0.4 L/ha + 0.1 L/ha	1.3
3.	Sencorex Flow + Stomp Aqua + Venzar 500 SC + HDC H44	metribuzin + pendimethalin + lenacil + Confidential	1 L/ha + 2.9 L/ha + 0.4 L/ha + 1.5 L/ha	1.7
9	Sencorex Flow + Stomp Aqua + Venzar 500 SC	metribuzin + pendimethalin + lenacil	1 L/ha + 2.9 L/ha + 0.4 L/ha	1.7

* The four most effective treatments for weed control are listed in this table but there were no significant differences in weed control between treatments 2,3,4,5,6,8,9 and 10.

Phytotoxic yellowing associated with HDC H44 (as part of a tank mixture; Treatment 3) resulted in very similar results to those obtained in 2018 trials (see 2018 annual report) with some damage in all species 2 WAT (see **Figures 1 to 4** in results of Science section). By 12 WAT all species had grown away from this initial damage and were considered commercially acceptable.

HDC H42 (as part of a tank mixture, Treatment 8) was initially the most damaging treatment within the trial (see appendix 2 **Figures 1 - 4**); however by 12 WAT all species were considered commercially acceptable. This treatment delivered the best weed control.

HDC H46 alone did not provide persistent weed control beyond 6 WAT (see **Table 3**) whereas HDC H46 applied as a tank mix (with Sencorex Flow + Stomp Aqua + Venzar 500 SC) resulted in 1.3 percent weed cover 12 WAT.

All of treatments were crop safe and effective (12 WAT) and resulted in significantly improved weed control compared to untreated controls, see **Table 19** (Science section).

Table 5 below shows that all of the treatments have potential for use in the production of field-grown trees. All scores were above 8 and the test species were considered tolerant to the herbicides.

Table 5. Average phytotoxicity scores for *Malus*, *Prunus*, *Quince* and *Sorbus* assessed 12 WAT (assessed 26/07/19).

Trt. No.	Planting	Rate (Kg/ha or L/ha)	<i>Malus</i>	<i>Prunus</i>	<i>Quince</i>	<i>Sorbus</i>
1	Untreated	-	9	9	9	9
2	Sencorex Flow + Stomp Aqua + Venzar 500 SC + HDC H47	1 L/ha + 2.9 L/ha + 0.4 L/ha + 3.75 L/ha	9	9	9	9
3	Sencorex Flow + Stomp Aqua + Venzar 500 SC + HDC H44	1 L/ha + 2.9 L/ha + 0.4 L/ha + 1.75 L/ha	9	9	9	8.6
4	Sencorex Flow + Stomp Aqua + Venzar 500 SC + Sunfire	1 L/ha + 2.9 L/ha + 0.4 L/ha + 0.48 L/ha	9	9	9	9
5	Sencorex Flow + Stomp Aqua + Venzar 500 SC + HDC H43	1 L/ha + 2.9 L/ha + 0.4 L/ha + 2.0 L/ha	9	9	9	9
6	Sencorex Flow + Stomp Aqua + Venzar 500 SC + HDC H46	1 L/ha + 2.9 L/ha + 0.4 L/ha + 0.1 L/ha	9	9	9	9
7	HDC H46	0.1 L/ha	9	9	9	9
8	Sencorex Flow + Stomp Aqua + Venzar 500 SC + HDC H42	1 L/ha + 2.9 L/ha + 0.4 L/ha + 1.5 L/ha	9	8.3	8.3	8.3
9	Sencorex Flow + Stomp Aqua + Venzar 500 SC	1 L/ha + 2.9 L/ha + 0.4 L/ha	9	9	9	9
10	Sencorex Flow	1.15 L/ha	9	9	9	9

The post budding treatments Shark (applied as an inter-row spray), Flexidor, Springbok and Venzar 500SC (applied over the foliage) were crop safe with any treatment effects being considered commercially acceptable (see **Table 7, appendix 2**), no weed was present 2 WAT (**Table 6, appendix 2**).

Hardy nursery stock container trial 2018 year two

The 2018 hardy nursery stock container trial was carried out at Wyevale nurseries, Hereford, on ten species of container-grown plants (**Table 6**). The trial consisted of six herbicide programmes, applied post-potting and as a top up treatment. The treatments applied in 2018 are detailed in the 2018 annual report. In the second year of the trial a further top up application of residual herbicides were applied in late winter (early March 2019). Treatments included an untreated control, a mulch (Sinclair pot topper applied post potting in 2018) and three herbicide products: Defy, Venzar 500 SC and the coded product HDC H46 (**Table 7**). Any weeds were removed before residual herbicides were applied.

Phytotoxicity was assessed at two, six, and twelve weeks after the herbicide treatments were applied on 08/03/19.

Table 6. Species and cultivars included in hardy nursery stock container trial 2018 year two.

Species	Cultivar
<i>Buxus sempervirens</i>	
<i>Ceanothus thyrsiflorus</i>	'Skylark'
<i>Cistus x purpureus</i>	
<i>Cornus Alba</i>	'Red Selection'
<i>Euonymus japonicus</i>	'Green Rocket'
<i>Hydrangea paniculata</i>	'Limelight'
<i>Ilex aquifolium</i>	
<i>Olearia x haastii</i>	
<i>Perovskia atriplicifolia</i>	'Blue Spire'
<i>Sambucus nigra</i>	'Black Lace'

Table 7. Treatment list, active ingredients and timings for the hardy nursery stock container herbicide trial (2018 /2019).

Treatment		Active ingredient	Approval status	Rate (L/ha)	Timing
1	Untreated	-	-	-	-
2	Sinclair pot topper	Physical mulch	-	3 cm depth	June 2018 (post-potting)
3	Defy	Prosulfocarb 800g/L	EAMU	5.0	March 2019
4	Defy + HDC H46	Confidential	EAMU + Not approved	5.0 + 0.1	
5	HDC H46	Confidential	Not approved	0.1	
6	HDC H46 + Venzar 500 SC	Confidential	Not approved + LTAEU	0.1 + 0.4	
7	Defy + HDC H46 + Venzar 500 SC	Confidential	EAMU + Not approved + LTAEU	5.0 + 0.1 + 0.4	
8	Defy + Venzar 500 SC	Confidential	EAMU + LTAEU	5.0 + 0.4	

The new herbicide HDC H46 was safer as a late winter treatment than application timings tested in 2018 (see 2018 annual report). This treatment resulted on initial slight damage on *Cistus* and *Sambucus* however damage did not become apparent on *Buxus*, *Euonymus* and *Hydrangea* until 6 weeks after treatment (WAT). By 12 WAT all species (with the exception of *Cistus*) were considered commercially acceptable.

Defy caused some initial damage on *Buxus* which was considered commercially acceptable by 6WAT. All species tested (with the exception of *Buxus*) were considered commercially acceptable throughout the trial.

Defy tank mixed with Venzar - all of the ten species were considered commercially acceptable throughout the trial.

The combination of Defy tank mixed with HDC H46 resulted in damage on more species than either of these treatments did when applied alone. By 12 WAT all species with the exception of *Cistus* had grown away from phytotoxic damage and were considered commercially acceptable with a score of 7 or above. *Ceanothus* appear to be sensitive to this tank mixture however damage did not show until 12 WAT. By 12 WAT eight of the ten species were considered commercially acceptable.

Defy tank mixed with HDC H46 and Venzar 500 SC resulted in damage on various species. By 12 WAT seven species of the ten species were considered commercially acceptable;

this treatment was too damaging and is not considered suitable for *Ceanothus*, *Cistus* or *Euonymus*.

Hardy nursery stock container trial 2019

This 2019 hardy nursery stock herbicide trial was set up at Darby Nursery Stock, Norfolk, in May 2019. The trial consisted of twenty container-grown hardy nursery stock species (**Table 8**). The trial consisted of six herbicide programmes, applied post-potting on 31/05/19 or as a top up treatment on 02/10/19, (**Table 9**).

Phytotoxicity was assessed at two, six, and twelve (May treatments) and again at two, six, and eleven (October treatments) weeks after the herbicide treatments were applied.

Table 8. Species and cultivars included in hardy nursery stock container trial 2019 (hereafter referred to by species).

Species	Cultivar
<i>Berberis thunbergii f. atropurpurea</i>	'Atropurpurea Nana'
<i>Chaenomeles x superba</i>	'Crimson and Gold'
<i>Choisya ternate</i>	
<i>Convolvulus cneorum</i>	
<i>Cotoneaster dammeri</i>	
<i>Cytisus</i>	'Lena'
<i>Diervilla splendens</i>	'Diva'
<i>Escallonia</i>	'Red Elf'
<i>Hebe x franciscana</i>	'Variegata'
<i>Hypericum</i>	'Hidcote'
<i>Lavandula vera</i>	
<i>Lavateria Hybrida</i>	'Barnsley'
<i>Ligustrum ovifolium</i>	'Aureum'
<i>Pachysandra terminalis</i>	'Green Sheen'
<i>Photinia x fraseri</i>	'Red Select'
<i>Potentilla fruticose</i>	'Abbotswood'
<i>Pyracantha</i>	'Soleil d'Or'
<i>Santolina chamaecyparissus</i>	
<i>Senecio compacta</i>	'Drysdale'
<i>Vinca minor</i>	

Table 9. Treatment list, active ingredients and timings for the hardy nursery stock container herbicide trial.

Treatment		Active ingredient	Approval status	Rate (L/ha)	Timing
1	Untreated	-	-	-	-
2	HDC H46	Confidential	Not approved	0.1	May (post-potting)
3	Flexidor + HDC H43	isoxaben 500 g/L + pethoxamid	Label + Not approved	0.5+ 2.0	
4	Flexidor + Centurion Max	isoxaben 500 g/L + clethodim 120 g/L	Label + LTAEU	0.5 + 2.0	
5	Flexidor + Sunfire	isoxaben 500 g/L + flufenacet 500 g/L	Label + EAMU 1065/17	0.5 + 0.48	
6	Flexidor + Dual Gold	isoxaben 500 g/L + S-metolachlor	Label + EAMU 0501/12	0.5 + 0.78	
7	Flexidor	isoxaben 500 g/L	Label	0.5	
1	Untreated	-	-	-	
2	Flexidor	isoxaben 500 g/L	Label	0.5	October top up
3	Springbok	dimethanid-p + metazachlor	EAMU 2108/15	1.6	
4	Springbok + HDC H43	dimethanid-p + metazachlor + pethoxamid	EAMU 2108/15 + Not approved	1.6 + 2	
5	Springbok + HDC H43 + Venzar 500 SC	dimethanid-p + metazachlor + pethoxamid + lenacil	EAMU 2108/15 + Not approved + LTAEU*	1.6 + 2 + 0.4	
6	HDC H43	pethoxamid	Not approved	2	
7	HDC H46	Confidential	Not approved	0.1	

* An EAMU for the use of Venzar 500 SC was granted in December 2019 however the EAMU restricts use to before the end of July.

Treatment application at potting, 31/05/19

At 2 weeks after treatment (WAT, Flexidor applied post-potting appeared to have caused some initial scorch. By 12 WAT all species were considered commercially acceptable.

The new herbicide HDC H46 caused more damage than Flexidor alone as it did in the trials carried out in 2018. Three species (*Cotoneaster*, *Lavandula* and *Photinia*) scored below 7.0 at twelve weeks after treatment and were not considered commercially acceptable; see **Table 10**.

Flexidor tank mixed with either Centurion Max, HDC H43, Sunfire or Dual Gold resulted in increased initial phytotoxicity on *Berberis* and *Lavandula* in all of the aforementioned treatments 2 WAT. By 12 WAT the majority of species were considered commercially acceptable. *Lavandula* was an exception with plants in all treatments still exhibiting phytotoxic symptoms (see **Table 10**). *Lavandula* treated with Flexidor alone was the only treatment on *Lavandula* where phytotoxic damage 12 WAT was considered commercially acceptable.

Table 10. Average phytotoxicity scores for hardy nursery species, twelve weeks after May treatment application (assessed 23/08/19).

Species	UTC	HDC H46	Flexidor + HDC H43	Flexidor + Centurion Max	Flexidor + Sunfire	Flexidor + Dual Gold	Flexidor
<i>Berberis thunbergii f. atropurpurea</i>	9	8.3	9	9	9	8.7	9
<i>Chaenomeles x superba</i>	9	8.7	8.7	8.3	9	9	8.7
<i>Choisya ternata</i>	9	9	9	9	8	9	9
<i>Convolvulus cneorum</i>	9	9	9	9	9	9	9
<i>Cotoneaster dammeri</i>	9	5.3	7.7	8	8.3	8.3	8.3
<i>Cytisus</i>	9	9	9	9	9	9	9
<i>Diervilla splendens</i>	9	8	9	9	9	9	8.3
<i>Escallonia</i>	9	9	9	9	8	9	9
<i>Hebe x franciscana</i>	9	7.6	9	9	9	9	9
<i>Hypericum</i>	9	8	7.7	7	7.3	9	8.3
<i>Lavandula vera</i>	9	6	6.3	5.7	6.3	6.7	7.7
<i>Lavateria Hybrida</i>	9	9	9	9	9	9	9
<i>Ligustrum ovifolium</i>	9	9	9	9	8	9	9
<i>Pachysandra terminalis</i>	9	8	9	9	9	9	9
<i>Photinia x fraseri</i>	9	5.7	8.7	8.7	8	9	9
<i>Potentilla fruticosa</i>	9	9	8.3	8.3	9	8	9
<i>Pyracantha</i>	9	8.7	9	9	9	9	9
<i>Santolina chamaecyparissus</i>	9	9	9	9	9	9	9
<i>Senecio compacta</i>	9	9	9	9	9	9	9
<i>Vinca minor</i>	9	8.7	8.3	9	9	9	9

Top up applications, 02/10/19

Any weeds were removed from the pots by hand before top up applications were applied, in line with standard nursery practice. Post-treatment the trial was assessed for phytotoxicity damage at 2, 6 and 12 WAT. Most plants were barely affected by the treatments at 2 WAT, with the exception of *Lavandula* where all treatments resulted in some phytotoxic damage and *Pachysandra* where all treatments other than Flexidor and Springbok alone resulted in phytotoxic damage that was not considered commercially acceptable. *Lavandula* treated with HDC H43 and HDC H46 scored below 7 at 12 WAT. HDC H46 and Springbok tank mixed with HDC H43 and Venzar 500 SC at 12 WAT resulted in *Pachysandra* scoring below 7 at 12 WAT, so was not considered a commercially acceptable treatment. *Photinia* was initially slightly damaged by the tank mix of Springbok, HDC H43 and Venzar 500 SC but was considered commercially acceptable by 6 WAT. *Photinia* was also damaged by HDC H46, treated plants had not recovered sufficiently for the treatment to be considered commercially acceptable scoring below 7 at 12 WAT. By 12 WAT the majority of species had recovered and any remaining damage was considered commercially acceptable.

Table 11. Average phytotoxicity scores for hardy nursery species, eleven weeks after October treatment application (assessed 20/12/19).

Species	UTC	Flexidor	Springbok	Springbok + HDC H43	Springbok + HDC H43 + Venzar 500 SC	HDC H43	HDC H46
<i>Berberis thunbergii f. atropurpurea</i>	9	9	9	9	9	9	9
<i>Chaenomeles x superba</i>	9	9	9	9	9	9	9
<i>Choisya ternata</i>	9	9	9	9	9	9	9
<i>Convolvulus cneorum</i>	9	9	9	9	9	9	9
<i>Cotoneaster dammeri</i>	9	8.7	9	9	9	8	9
<i>Cytisus</i>	9	9	9	9	9	9	9
<i>Diervilla splendens</i>	9	9	9	9	9	9	9
<i>Escallonia</i>	9	9	9	9	9	9	9
<i>Hebe x franciscana</i>	9	8.3	9	7.3	8	9	7
<i>Hypericum</i>	9	9	9	8.3	8.7	8.7	8
<i>Lavandula vera</i>	8	7.3	8	7.7	7	6.3	5.7
<i>Lavateria Hybrida</i>	9	9	9	9	9	9	9
<i>Ligustrum ovifolium</i>	9	9	9	9	9	9	9

<i>Pachysandra terminalis</i>	9	8.3	9	7	6.3	7.7	5.3
<i>Photinia x fraseri</i>	9	8	9	7	7	7.7	6.7
<i>Potentilla fruticosa</i>	9	9	9	9	9	9	9
<i>Pyracantha</i>	9	9	9	9	9	9	9
<i>Santolina chamaecyparissus</i>	9	9	9	9	9	9	9
<i>Senecio compacta</i>	9	9	9	9	8.4	9	9
<i>Vinca minor</i>	9	9	9	9	8.7	8.7	9

Conclusions

- The EAMU for use of Sencorex Flow will allow the application of effective tank mix combinations after planting and heading back.
- Sencorex Flow could form the basis of residual herbicide programmes post-planting and post heading back at a higher rate than previously used on field-grown trees as an alternative to Flexidor to deliver crop safe, effective weed control.
- Dual Gold, Sunfire and Centurion Max have shown potential for use over hardy nursery stock foliage in tank mixes with Flexidor to broaden weed control spectrums. In terms of crop safety, whilst safe on most of the species tested by 12 WAT growers should be prepared for some varietal susceptibility.
- Defy applied as a late winter treatment appear crop safe, and are recommended for taking forward to future trials work.
- Defy could be a partial alternative to Devrinol (napropamide) as a winter treatment for container-grown hardy nursery stock to help manage and prevent herbicide resistance. Growers should note that Devrinol will give superior control of groundsel than Defy.
- New coded herbicides all have potential to contribute to weed control in the production of hardy nursery stock providing that appropriate authorisations / EAMUs can be obtained.

Financial Benefits

Hand weeding three times during the growing season is estimated to cost in the region of £30,000 per hectare for field crops, such as trees. The effective use of residual herbicides – minimising the need for hand weeding or the application of direct contact herbicides – will help to reduce costs significantly, contributing to grower profitability. For example, herbicide mixtures of standard and experimental products with Sencorex Flowable appeared to provide improved weed control compared with Sencorex alone. The LTAEU in place for Venzar 500 SC when this trial commenced has been transferred to an EAMU, resulting in the unforeseen limitation of not being able to apply Venzar 500 SC after the end of July in the year of application. This prevents use at some of the timings detailed within this report, a loss which may slightly reduce the effectiveness of some treatments. The impact on weed control should not be particularly detrimental as the low rates used (0.4 L/ha) would have limited and fairly short persistence.

Centurion Max, Dual Gold, Springbok, Sunfire, Defy, Venzar 500 SC and HDC H46 were evaluated for container-grown hardy nursery stock production. At present there is no financial benefit for Defy because an improved EAMU permitting use over the top of dormant crops would be required; current off-label approval for use of Defy in outdoor and protected ornamental plant production (EAMU 1431/13) only allows pre-emergence use.

Action Points

- For budded tree production in the field, herbicide programmes of Sencorex Flow + Stomp Aqua + Venzar 500 SC + Sunfire after planting and after heading back are recommended.
- Tank mixes of Flexidor with the selective contact grass herbicide Centurion Max or residual herbicide Sunfire, appeared safe on container-grown hardy nursery stock.
- Tank mixes of Flexidor with Dual Gold appeared safe on the majority of species and can be applied in May.
- Springbok has potential as a top up treatment in both field and container production when foliage hardens later in the year.
- Applying 10 mm of irrigation, post-herbicide application, could be adopted by growers to help minimise crop damage associated with some of the treatments.